



[SPECIFICATION]

TITLE

BIAS-T APPARATUS AND CENTER CONDUCTOR OF THE SAME

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a mobile communication system, and more particularly to a bias-T apparatus and its center conductor for providing radio frequency signals and power source to outdoor equipment of a Base Transceiver Station (BTS) in a mobile communication system.

Description of the Related Art

In general, ground equipment in a tower-top BTS either employs a pre-amplifier or enables an upward/downward frequency converter to have an additional amplifying function, in order to compensate for loss of signal or power in an inter facility link cable (IFL) connected to a remote radio frequency (RF) unit located in outdoor equipment (an antenna tower) of the BTS. In addition, the ground equipment also employs a bias-T apparatus or line amplifier, in order to supply electric power to the remote RF unit located in the antenna tower.

FIG. 1 is a block diagram of one example of conventional tower-top BTSs. Referring to FIG. 1, a conventional BTS includes a ground BTS 100 constructed on the ground and an antenna tower 114 constructed outdoor in order to improve the transmission/reception level of radio frequency (RF) signals.

1 Hereinafter, the construction of the ground BTS 100 will be referred first. A  
2 control/interfacing unit 102 performs signal matching with a base station controller (BSC) for  
3 controlling the BTS and generally controls the operation of the BTS. A digital processor 104  
4 CDMA-modulates and -demodulates forward and backward signals according to the control of the  
5 control/interfacing unit 102. An upward/downward frequency converter 106 upward-converts the  
6 forward signal into a signal of a CDMA wireless band and downward-converts the backward signal  
7 into an intermediate frequency signal used in the digital processor 104. A pre-amplifier 108  
8 compensates for line loss of the signal outputted from the upward/downward frequency converter  
9 106 and amplifies the signal to meet input requirements for RF processing of the signal by the  
10 antenna tower 114. A bias-T circuit 110 synthesizes power and the output signal of the pre-amplifier  
11 108 and transmits the synthesized signal through an IFL cable to the antenna tower 114, and a bias-T  
12 circuit 112 receives a signal from the antenna tower 114 and transmits the signal to the  
13 upward/downward frequency converter 106.

14 Next, the antenna tower 114 will be described, which includes a main amplifier 116, a low  
15 noise amplifier 124, and antennas 118 and 120. The main amplifier 116 amplifies power of the  
16 signal from the bias-T circuit 110 up to a level which meets a standard required for a forward radio  
17 link to a mobile subscriber terminal. The low noise amplifier 124 amplifies with minimum noise  
18 the signal received from the antenna 120 and then transmits the amplified signal to the bias-T circuit  
19 112.

20 FIG. 2 is a circuit diagram of the bias-T circuit shown in FIG. 1. In the bias-T circuit as  
21 shown in FIG. 2, when the signal outputted from the pre-amplifier 108 is inputted through a signal

1 input node a, the signal is outputted to a signal output node b through a capacitor C1 but is not  
2 outputted to another node c through which direct current is applied. It is because the inputted signal  
3 is a radio frequency signal which causes the node c to have an infinite impedance due to an inductor  
4 L1. Further, direct current (DC) power is inputted through the power input node c and the inductor  
5 L1. Therefore, the output signal of the pre-amplifier 108 and the DC power are synthesized through  
6 the bias-T circuit 110 and are then transmitted to the antenna tower 114.

7 Further, the bias-T circuit 112 processes the backward signal in the same way, thereby  
8 transmitting the backward signal to the upward/downward frequency converter 106.

9 There are several ways of constructing the capacitor C1. First, a chip capacitor may be  
10 employed. However, in this case, a portion between an input node and a transmission line causes  
11 the assembling of the capacitor to be more complicated and difficult.

12 Second, two electrode plates (that is, a center conductor) constituting the capacitor C1 are  
13 installed at a portion between the input node and the transmission line while being spaced a  
14 predetermined gap from each other. In general, a capacitor has a capacitance which is proportional  
15 to the area size of the electrode plates and inversely proportional to the distance between the  
16 electrode plates. However, recent electronic appliances and their elements tend to be lighter, thinner,  
17 shorter, and smaller, thereby causing it difficult to enlarge the area of the electrode plates in order  
18 to increase the capacitance since the area of the electrode plates has a large influence on the size of  
19 the capacitor. Therefore, a method of reducing the gap between the electrode plates is usually  
20 employed. However, there is a limitation in reducing the gap between the electrode plates, and thus  
21 there is a limitation in increasing the capacitance of the capacitor.

**SUMMARY OF THE INVENTION**

Accordingly, the present invention has been made to solve the above-mentioned problems occurring in the conventional art, and an object of the present invention is to provide a bias-T apparatus and its center conductor, in which electrode plates of a capacitor are opposed to each other with an increased area and with a gap of several microns between them, thereby increasing the capacitance of the capacitor and improving the performance of the apparatus.

In order to accomplish this object, the present invention provides a bias-T comprising: a housing including an input connector and an output connector integrally formed at opposite sides of the housing, the input connector being connected to a transceiver system, the output connector being connected to an antenna, the housing having a housing hole and a fixing hole, the housing hole being formed longitudinally through central portions of the input and output connectors, the fixing hole being formed through a central upper portion of the housing; and a center conductor connected to the input and output connectors, thereby enabling electric connection between them.

In accordance with another aspect of the present invention, there is provided a center conductor of a bias-T having a housing which has a housing hole and includes an input connector and an output connector formed at opposite sides of the housing hole. The input connector is connected to a transceiver system, and the output connector is connected to an antenna. The center conductor includes a first conductor inserted in a first housing hole portion formed through a central portion of the output connector and a second conductor inserted in a second housing hole portion formed through a central portion of the input connector. The first conductor has a reception tube, and the second conductor has a conductor shaft. The conductor shaft is inserted in the reception tube

1 so that the first conductor and the second conductor are assembled with each other in the housing  
2 hole. At least one of an inner surface of the reception tube and an outer surface of the conductor  
3 shaft is anodized.

#### 4 **BRIEF DESCRIPTION OF THE DRAWINGS**

5 The above and other objects, features and advantages of the present invention will be more  
6 apparent from the following detailed description taken in conjunction with the accompanying  
7 drawings, in which:

8 FIG. 1 is a block diagram of an example of conventional tower-top base transceiver systems;

9 FIG. 2 is a circuit diagram of the bias-T circuit shown in FIG. 1;

10 FIG. 3 is a perspective view of a center conductor according to an embodiment of the present  
11 invention;

12 FIG. 4 is an exploded perspective view of a bias-T apparatus according to an embodiment  
13 of the present invention; and

14 FIG. 5 is an assembled side-sectional view of the bias-T apparatus shown in FIG. 4.

#### 15 **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT**

16 Hereinafter, preferred embodiments of the present invention will be described with reference  
17 to the accompanying drawings. In the following description of the present invention, a detailed  
18 description of known functions and configurations incorporated herein will be omitted when it may  
19 make the subject matter of the present invention rather unclear.

1           The detailed description of the preferred embodiments of the present invention with reference  
2           to the accompanying drawings is described hereinafter.

3           FIG. 3 is a perspective view of a center conductor according to an embodiment of the present  
4           invention, FIG. 4 is an exploded perspective view of a bias-T apparatus according to an embodiment  
5           of the present invention, and FIG. 5 is an assembled side-sectional view of the bias-T apparatus  
6           shown in FIG. 4. FIGs. 4 and 5 show a state in which the center conductor 300 shown in FIG. 3 is  
7           inserted into the bias-T apparatus.

8           Referring to FIG. 3, a center conductor 300 includes a first conductor 400 and a second  
9           conductor 402 assembled with each other. The center conductor 300 can function as a capacitor and  
10          provide electric connection between the ground BTS and the antennas when the first conductor 400  
11          and the second conductor 402 have been assembled with each other. A center hole 302 formed in  
12          the center conductor 300 has a screwed portion which enables a fixing pin 406 to be  
13          screw-assembled in the center hole 302. The fixing pin 406 enables DC power to be supplied  
14          through the fixing pin 406.

15          Referring to FIGs. 4 and 5, the bias-T apparatus has a housing 412. The housing 412 has a  
16          housing hole and a fixing hole 414. The housing hole is formed longitudinally through the housing  
17          412, and the fixing hole 414 is formed through an upper portion of the housing 412 and is connected  
18          to the housing hole. The housing 412 includes an input connector 408 and an output connector 410  
19          which are integrally formed at opposite sides of the housing 412. The input connector 408 is  
20          connected to the ground BTS, and the output connector 410 is connected to the antenna side. The  
21          center conductor 300 including the first conductor 400 and the second conductor 402 is inserted in

1 the housing hole formed in the housing 412.

2 The first conductor 400 of the center conductor 300 is disposed in the housing hole. The first  
3 conductor 400 includes a first connector pin and a reception tube which form opposite ends of the  
4 first conductor 400. The first connector pin is connected through the output connector 410 to the  
5 antenna side. The reception tube is hollow and thus has a reception hole which is formed in the  
6 reception tube and extends in the longitudinal direction of the housing hole. Preferably, the  
7 reception tube has a cylindrical shape. The housing hole has a first housing hole portion 500  
8 formed through a central portion of the output connector 410 and a second housing hole portion 502  
9 formed through a central portion of the input connector 408. The first conductor 400 having the  
10 construction described above is inserted into the first housing hole portion 500. The second  
11 conductor 402 of the center conductor 300 is also disposed in the housing hole of the housing 412.  
12 The second conductor 402 has a second connector pin 402a and a conductor shaft 404 which form  
13 opposite ends of the second conductor 402. The second connector pin 402a is connected to the  
14 ground BTS through the input connector 408. The conductor shaft 404 is inserted in the reception  
15 hole formed in the reception tube of the first conductor 400. The conductor shaft 404 has an  
16 anodized outer surface. The second conductor 402 is inserted in the second housing hole portion 502  
17 of the housing hole formed inside of the input connector 408. The conductor shaft 404 has a shape  
18 corresponding to that of the reception tube, preferably a cylindrical shape.

19 In assembling the center conductor 300 as described above, the first conductor 400 is inserted  
20 in the first housing hole portion 500 inside of the output connector 410 and the second conductor 402  
21 is inserted in the second housing hole portion 502 inside of the input connector 408, and then the

1 conductor shaft 404 of the second conductor 402 is inserted in the reception tube of the first  
2 conductor 400, so that the first conductor 400 and the second conductor 402 are assembled with each  
3 other in the housing 412.

4 In the center conductor 300 constructed by the first conductor 400 and the second conductor  
5 402 as described above, the conductor shaft 404 and the reception tube will function as electrode  
6 plates of the capacitor. Therefore, contact surfaces between the conductor shaft 404 and the  
7 reception tube corresponding to electrode plates of the capacitor can be enlarged without increasing  
8 the entire size of the center conductor 300 by simply increasing a degree by which the conductor  
9 shaft 404 is inserted in the reception tube. Further, the outer surface of the conductor shaft 404 (or  
10 the inner surface of the reception tube) is anodized, that is, an oxide film is formed on the outer  
11 surface of the conductor shaft 404 or the inner surface of the reception tube. Therefore, the  
12 conductor shaft 404 and the reception tube can be in close contact with each other while enabling  
13 them to function as the electrode plates of the capacitor, so that the gap between the conductor shaft  
14 404 and the reception tube functioning as the electrode plates can be reduced up to several microns.

15 Meanwhile, the fixing pin 406 is vertically inserted into the center hole 302 of the first  
16 conductor 400 so as to fix the first conductor 400 to the housing 412 and apply DC power to the  
17 output side of the transmission signal of the center conductor 300.

18 In the housing 412 of the bias-T apparatus, the input connector 408 connected to the ground  
19 BTS and the output connector 410 connected to the antenna side are formed integrally with opposite  
20 sides of the housing 412. The housing hole formed in the housing 412 includes the first housing  
21 hole portion 500 in which the first conductor 400 can be inserted and the second housing hole



1 portion 502 in which the second conductor 402 can be inserted. Also, the housing 412 has the fixing  
2 hole 414 in which the fixing pin 406 can be vertically fitted. Moreover, a recess 416 for receiving  
3 various elements is formed at an upper portion of the housing 412, which is located above and  
4 connected to the fixing hole 414. The recess 416 may receive either an EMI filter including coils  
5 and dielectric materials or a gas tube arrester and diodes for protecting the ground BTS from the  
6 surge voltage introduced from the output connector 410.

7 Hereinafter, the operation of the bias-T apparatus in which the center conductor 300 has been  
8 inserted in the housing 412 will be described.

9 For example, when an RF signal is inputted to the second conductor 402, the RF signal  
10 passes through a capacitor formed by an assembly of the second conductor 402 and the first  
11 conductor 400 and is then outputted to an antenna. Meanwhile, DC power is supplied to the first  
12 conductor 400 through the EMI filter and the fixing pin 406. That is, the RF signal and the DC  
13 power are transmitted through the bias-T apparatus to the antenna tower. In this case, the RF signal  
14 is not outputted toward the fixing pin 406 to which the DC power is applied, because an inductor,  
15 a coil constructing the EMI filter, causes the impedance of the fixing pin 406 to be infinite. Further,  
16 the DC power is not outputted to the second conductor 402, because the first conductor 400 and the  
17 second conductor 402 assembled with each other construct a capacitor. That is, the second  
18 conductor 402 has an infinite impedance with respect to the DC power.

19 Although the above description is given about the operation of the bias-T apparatus when a  
20 forward signal is inputted, the bias-T apparatus operates in the same manner for the backward signal  
21 also.

1           FIG. 5 is a sectional view of a bias-T apparatus according to an embodiment of the present  
2           invention. FIG. 5 shows a state in which the center conductor 300 and the fixing pin 406 have been  
3           inserted in the housing 412 shown in FIG. 4. Referring to FIG. 5, the first conductor 400 is inserted  
4           in the first housing hole portion 500 and the second conductor 402 is inserted in the second housing  
5           hole portion 502. A substrate 504 applies DC power to the fixing pin 406. Elements in addition to  
6           those described above can be seen from FIG. 4.

7           While the invention has been shown and described with reference to certain preferred  
8           embodiments thereof, it will be understood by those skilled in the art that various changes in form  
9           and details may be made therein without departing from the spirit and scope of the invention as  
10          defined by the appended claims. For example, instead of anodizing the outer surface of the  
11          conductor shaft 404, the inner surface of the reception tube may be anodized. Further, instead of  
12          the construction of the center conductor 300 described above in which the first conductor 400 has  
13          the reception tube and the second conductor 402 has the conductor shaft 404, the first conductor 400  
14          may have a conductor shaft and the second conductor 402 may have a reception tube.

15          Therefore, the present invention has a scope which is not restricted by the preferred  
16          embodiments described above but can be defined by the appended claims and their equivalents.

17           [INDUSTRIAL UTILITY]

18          As described above, the present invention enables the first conductor and the second  
19          conductor to be disposed in close contact with each other, even with a gap of several microns  
20          between them, by means of the anodized outer surface of the conductor shaft, without inserting a

1      separate element or soldering. That is, the present invention can increase the capacitance of the  
2      capacitor nearly without limitation by constructing the capacitor with the first and second conductors  
3      assembled together. Further, the present invention saves the manufacturing cost since it employs a  
4      bias-T apparatus having an integrated housing.